Developing Numeric Nutrient Criteria for Mississippi

Stakeholder Update

MDEQ Amite Street Offices
Jackson, MS
July 30, 2012

Water Quality Standards 101:

Overview of the Basics of the WQS Program

Kim Caviness, P.E., BCEE

MS Dept of Environmental Quality

Water Quality Standards and Special Projects Branch Chief

Water Quality Standards (WQS)

- Serve the purposes of the Clean Water Act
- Establish the water quality goals for a water body
- Protect public health and welfare
- Apply to ambient waters NOT to dischargers
- Protect designated uses

3 Components of WQS

- Designated Uses
- Water Quality Criteria (Narrative or Numeric)
- Antidegradation Policy

Designated Uses

- Uses specified in the water quality standards for each water body or segment whether or not they are being attained
- Attainment of these uses is determined based on water quality assessments
- Water quality assessments determine attainment based on specific numeric and narrative criteria which are specified in the WQS

Water Quality Criteria

- A concentration, level, or narrative statement
- Represent a level of water quality that supports a particular designated use
- States must adopt criteria that protect the designated use(s)
  - Based on a sound, scientific rationale
  - Sufficient parameters to protect the designated use
  - Must support the most sensitive use

Revisions to WQS

- Triennial Review – Required by the Clean Water Act
  - States are required to review WQS every 3 years
  - Must include public participation component
    - Public notice period (30 days)
    - Public hearing
- Revisions to the WQS must be
  - Adopted by the MS Commission on Environmental Quality
  - Concurred upon by U.S. Fish and Wildlife
  - Certified by the State of MS Attorney General
  - Submitted to EPA Region 4 for approval

Assessments, 303(d) List, TMDLs, and NPDES Permitting

- Water Quality Standards are the foundation for making assessments
  - Attainment of the Designated Use
  - 305(b) Report
- Waters not attaining their use – listed on the 303(d) List of Impaired Waters
- TMDLs must be developed for waters on the List
- NPDES permit limits must comply with water quality standards and criteria

Developing Numeric Nutrient Criteria:

The Mississippi Approach

How did we get here?

History of Nutrient Criteria

- 1990's – States' 305(b) and 303(d) reports indicate that nutrients are the #1 cause of lake impairments and the #2 cause of stream impairments
- 1998 – U.S. EPA issues the National Strategy for the Development of Regional Nutrient Criteria
- 2000-2001 – U.S. EPA releases guidance documents for nutrient criteria development based on water body type

History of Nutrient Criteria

- 2001 - EPA published numeric nutrient targets based on Ecoregions
  - Conservative numbers
- 2001 – EPA Action Plan for the Development and Establishment of Nutrient Criteria (Grubbs Memo)
  - States must either:
    - Adopt numeric nutrient criteria by 2004
    - Develop a plan by 2002
    - Most States opted to develop plans for determining their own criteria

History of MS's Nutrient Criteria Activities

- MDEQ established the Nutrient Task Force in 2000
  - Included Federal and State experts
  - Review historical data
  - Identify data gaps
  - Develop MS's initial approach
  - Recommend additional monitoring and data collection

Task Force Activities

- Decided that criteria should be developed based on water body type
  - Lakes and Reservoirs
  - Streams and Rivers
  - Estuaries and Coastal Waters
- Established different committees to focus on different water body types
- Developed the first Nutrient Criteria Development Plan for Mississippi

Implementing Our Plan

- Took action on the Task Force's recommendations
- Data and information gaps were identified by the Task Force
- Efforts were initiated to address these gaps
  - Data collection across various water body types
  - Establishing biological indicators
  - Preliminary nutrient criteria analyses

Where are we now?

Data Collection Efforts

- Data collection efforts have been underway to fill data and information gaps
- On-going MDEQ-Led Data Collection Efforts
  - Data collection efforts in all water body types across the state
  - Awarded EPA GMPO grant for intensive nutrient study of St. Louis Bay watershed
  - Continued sampling of benthic macroinvertebrate communities within wadeable streams throughout the state (M-BISQ)
  - Sampling of benthic communities and DO data within Delta waters
  - 319/BMA Projects

Tool Development

- MDEQ is developing/evaluating multiple tools in an attempt to make the connection between nutrient concentrations and biological response
  - M-BISQ Recalibration
  - Trophic State Index (TSI) for Lakes
  - Benthic Index for Coastal Waters
  - Benthic Index for Delta Waters
  - Fish IBI for Delta waters

Other On-Going Activities

- MDEQ has secured technical support from Tetra Tech for nutrient criteria development
- Actively engaged in national and regional nutrient initiatives
  - Gulf of Mexico Alliance
  - Hypoxia Task Force
- Re-established our Team
  - Nutrient Technical Advisory Group (TAG)

MS's Nutrient TAG Members

GULF COAST
RESEARCH LABORATORY
THE UNIVERSITY OF SOUTHERN MISSISSIPPI

United States Department Of Agriculture
Agricultural Research Service

Mission: Possible

- MDEQ's Mission:

  Develop appropriate and protective numeric nutrient criteria for Mississippi's waters that are scientifically defensible.

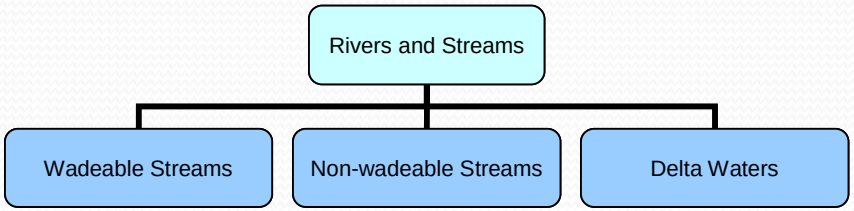
- TAG's Mission:

  Provide technical expertise and regional knowledge to MDEQ for the development of scientifically defensible numeric nutrient criteria.

Timeline

- System-wide approach to criteria development to ensure protection of downstream uses

- Public Comment Period Begins by June 30, 2013
  - Lakes and Reservoirs
  - Wadeable Streams
  - Non-wadeable Streams
  - Coastal and Estuarine Waters



- Public Comment Period Begins by November 30, 2014
  - Delta Waters

Where are we going?

Moving Forward in MS

- MDEQ will work through the criteria development process by water body type with TAG support
- Follow the mutually-agreed upon timeline in the Nutrient Criteria Development Plan
- TAG meetings will be held quarterly
- Stakeholder Outreach an MDEQ Priority
  - Will be done throughout the criteria development process
  - Opportunity for stakeholders to stay informed and also provide their comments and/or concerns regarding criteria development efforts

Beyond the Number

- More to criteria than coming up with the number
- MDEQ with guidance from the TAG will have to work through questions such as:
  - How will the number be written into our standards?
  - How will we monitor for nutrients?
  - How will we assess for nutrients?
  - How will we incorporate this number into permits?

Developing Numeric Nutrient Criteria: The Mississippi Approach

TETRA TECH

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

Big Picture

- Criteria are part of Water Quality Standards

  Designated Use + Water Quality Criteria + Anti-degradation Policy

- Designated Uses
  - Aquatic Life
  - Shellfish Harvesting and Consumption
  - Recreation
  - Drinking Water

- Nutrients affect all 3 of these and numeric criteria being developed to better protect them
  - Currently based on narrative “free from” criteria

Approach

- Guided by a Technical Advisory Group (TAG) of state experts from academia and agencies
- Based on EPA Nutrient Criteria Guidance
- Goal: scientifically defensible, protective criteria developed using a transparent, well-documented process

General Approach

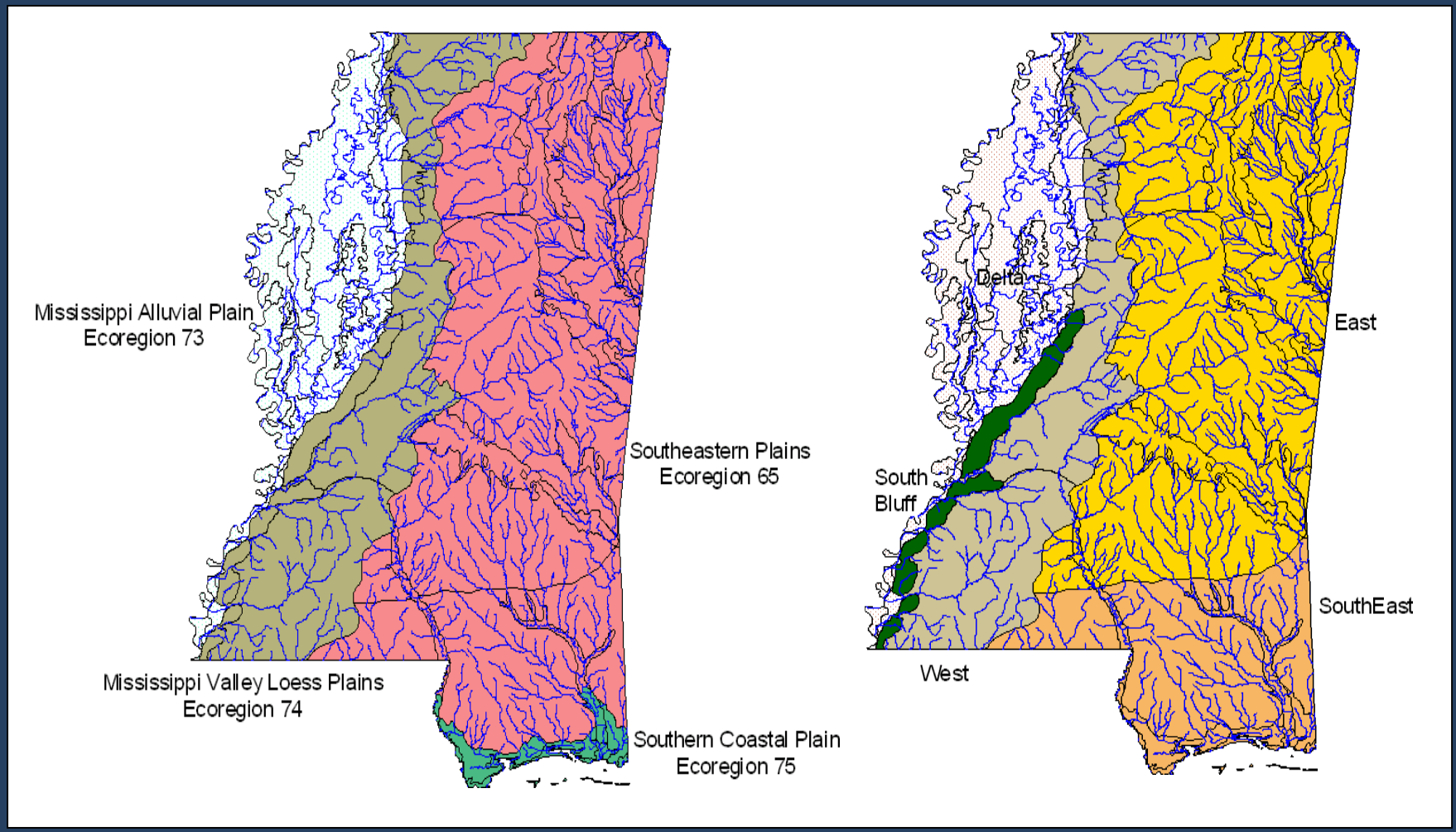
1. Data Compilation – compiling defensible datasets
2. Classification – comparing apples and apples
3. Data Analysis – identifying candidate endpoints
4. Criteria Derivation – from the candidate endpoints, deciding on the most defensible and protective criteria

Data Compilation

- Compile datasets consistent with state data quality requirements (DQOs, MQOs, etc.) relevant to criteria derivation

Classification

- Comparing apples to apples



Data Analysis: Multiple Lines of Evidence

- Using multiple lines of analysis to define a specific endpoint
- Alternative to single analysis approaches
- Especially useful with complex systems

"A weight of evidence approach that combines any or all of the three approaches above will produce criteria of greater scientific validity"

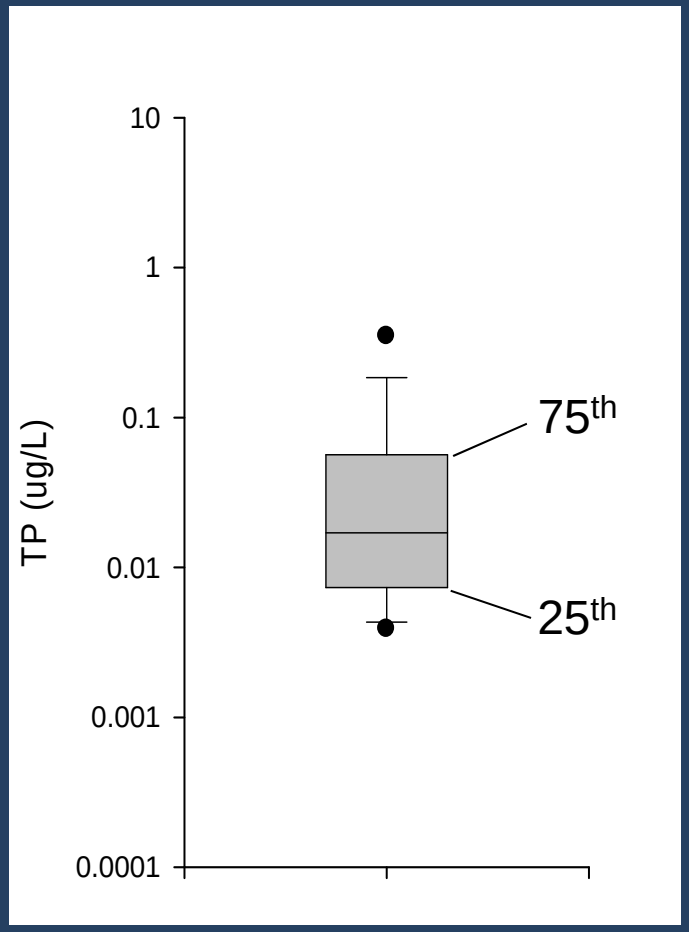
-USEPA 2000, SAB 2010

Approaches

Scientifically Driven

- Distributional Analysis (Reference Approach)
- Stressor-Response (Effects Based)
- Scientific Literature
- Models

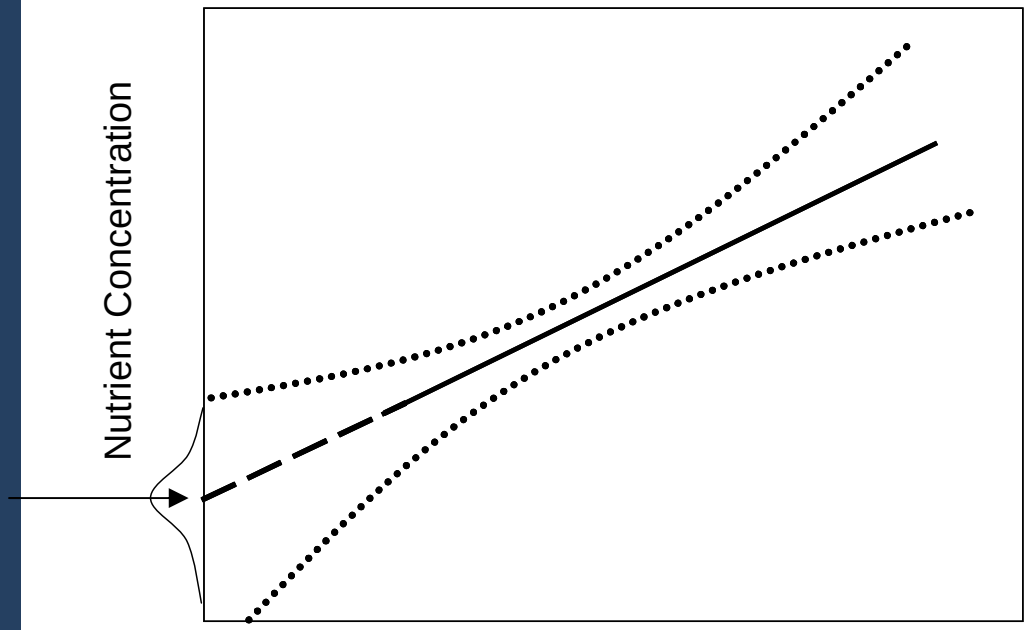
Distributional Approaches



- Reference
- All
- Attaining

Modeled Reference Expectation

- Model the reference condition
- Regression methods



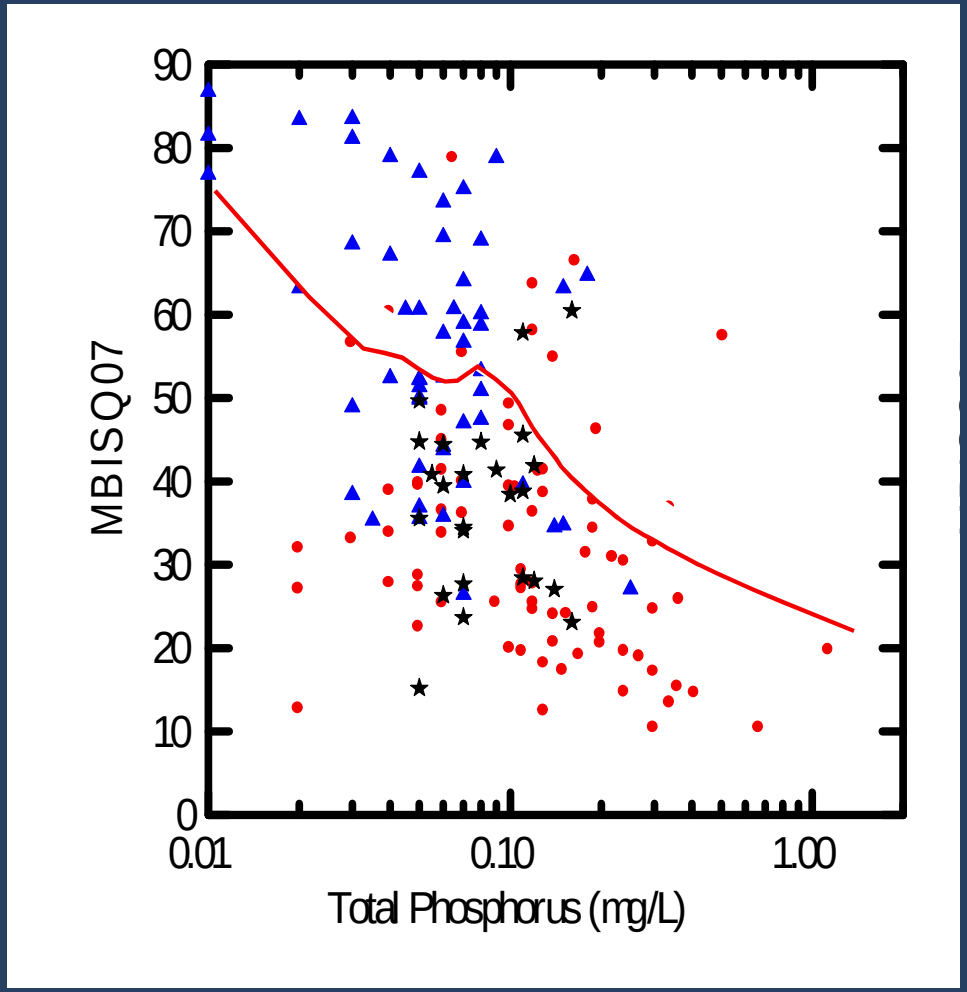
TN MODEL

LogTN = 0.1 + 0.49*Agriculture + 0.14*Urban

$TN = 10^{0.1} = 1.0$ mg/L

Stressor-Response

- Many methods
- Choose defensible ones
- Can be done in series



Scientific Literature

- Established thresholds
- Known effects levels

Comparing effects of nutrients on algal biomass in streams in two regions with different disturbance regimes and with applications for developing nutrient criteria

R. Jan Stevenson[1,*], Steven T. Rier[2], Catherine M. Riseng[3], Richard E. Schultz[4] & Michael J. Wiley[3]

[1]*Department of Zoology, Michigan State University, East Lansing, MI, 48824, USA*
[2]*Department of Biological & Allied Health Sciences, Bloomsburg University, Bloomsburg, PA, 17815, US*
[3]*School of Natural Resources and the Environment, The University of Michigan, Ann Arbor, MI, 48109,*
[4]*Department of Biological Sciences, University of Louisville, Louisville, KY, 40292, USA*
*(*Author for correspondence: E-mail: rjstev@msu.edu)*

SUGGESTED CLASSIFICATION OF STREAM TROPHIC STATE: DISTRIBUTIONS OF TEMPERATE STREAM TYPES BY CHLOROPHYLL, TOTAL NITROGEN, AND PHOSPHORUS

WALTER K. DODDS[1]*, JOHN R. JONES[2] and EUGENE B. WELCH[1]

[1]Division of Biology, Kansas State University, Manhattan, KS 66506, U.S.A., [2]School of Natural
Hall, University of Missouri, Columbia, MO 65211, U.S.A.
of Civil Engineering, P.O. Box 352700, University
shington, Seattle, WA 98195, U.S.A.

DEVELOPING NUTRIENT TARGETS TO CONTROL BENTHIC CHLOROPHYLL LEVELS IN STREAMS: A CASE STUDY OF THE CLARK FORK RIVER

W. K. DODDS[1]*, V. H. SMITH[2] and B. ZANDER[3]

[1]Division of Biology, Kansas State University, Manhattan, KS 66506, U.S.A., [2]Environmental Studies Program and Department of Systematics and Ecology, University of Kansas, Lawrence, KS 66045, U.S.A., [3]United States Environmental Protection Agency Region 8, Suite 500, 999 18th St. Denver, CO 80202, U.S.A.

Models

- Mechanistic
- Empirical

Stream Water Quality Model (QUAL2K)

QUAL2K (or Q2K) is a river and stream water quality model that is intended to represent a modernized version of the QUAL2E (or Q2E) model

- Sediment-wate
dissolved oxyge
rather than bei
nutrient fluxes
ticulate organic
and the concen
waters.

Bottom algae.
bottom algae.

Regional interpretation of water-quality monitoring data

Richard A. Smith, Gregory E. Schwarz, and Richard B. Alexander
U.S. Geological Survey, Reston, Virginia

Abstract. We describe a method for using spatially referenced regressions of contaminant transport on watershed attributes (SPARROW) in regional water-quality assessment. The method is designed to reduce the problems of data interpretation caused by sparse sampling, network bias, and basin heterogeneity. The regression equation relates measured transport rates in streams to spatially referenced descriptors of pollution sources and land-surface and stream-channel characteristics. Regression models of total phosphorus (TP) and total nitrogen (TN) transport are constructed for a region defined as

Multiple Lines of Evidence

45 µg/L

Distribution

40 µg/L

Literature

65 µg/L

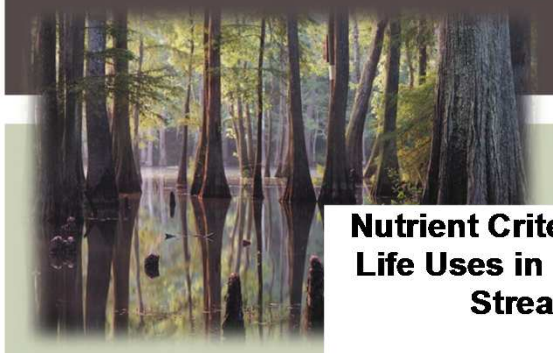
70 µg/L

Stressor-response

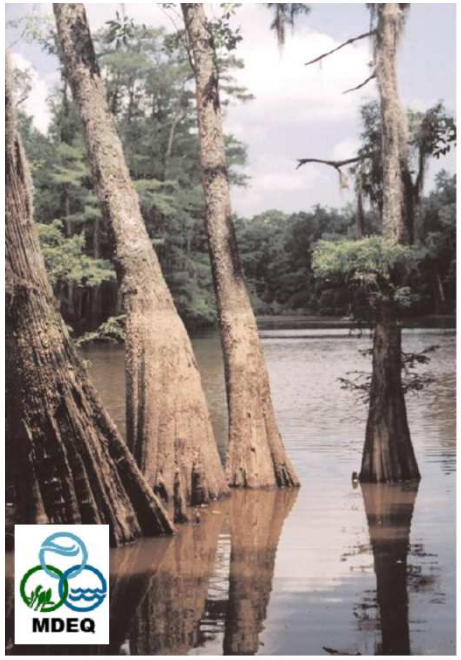
55 µg/L

Models

STREAMS AND RIVERS

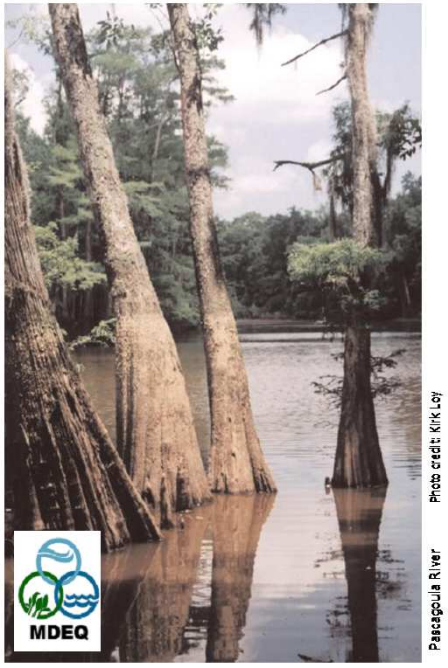


Nutrient Criteria to Protect Aquatic Life Uses in Mississippi Non-Tidal Streams and Rivers



June 8, 2009

Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Non-Tidal Streams and Rivers

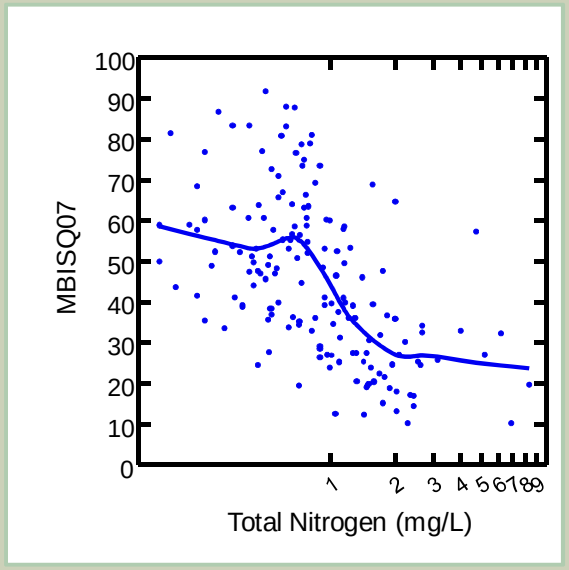


June 8, 2011

BIG PICTURE

1. Data Gathering/Exploration
   Completed

2. Classification
   Completed



3. Data Analysis
   Final Refinement

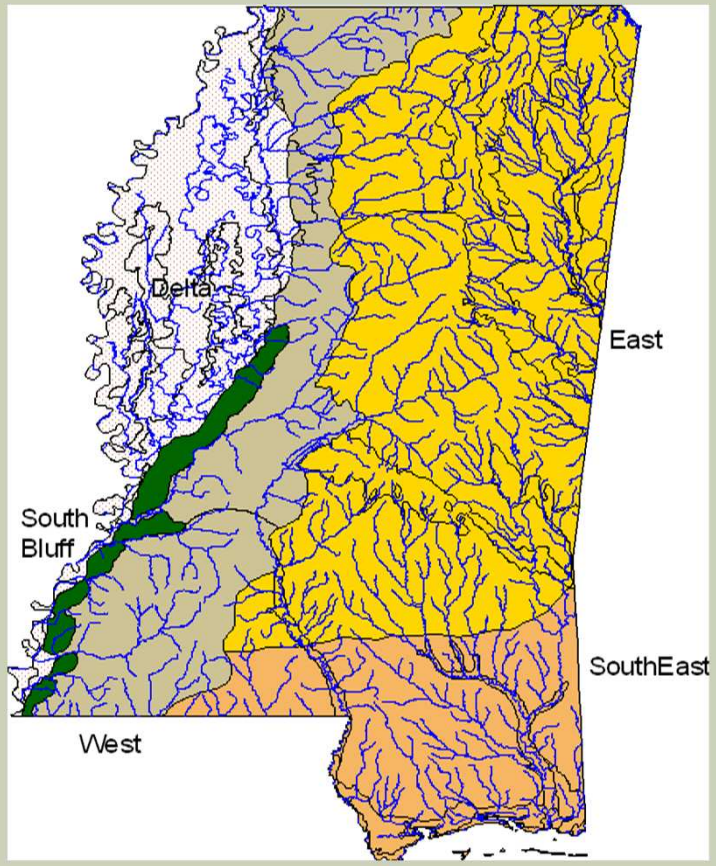
4. Recommended Thresholds
   Ongoing

DATA GATHERING

- MDEQ Statewide Stream Sampling Program
  - One of largest in US by now
  - Nutrient and response information
- USGS NWIS, USGS NAWQA
- EPA Nutrient Database/STORET

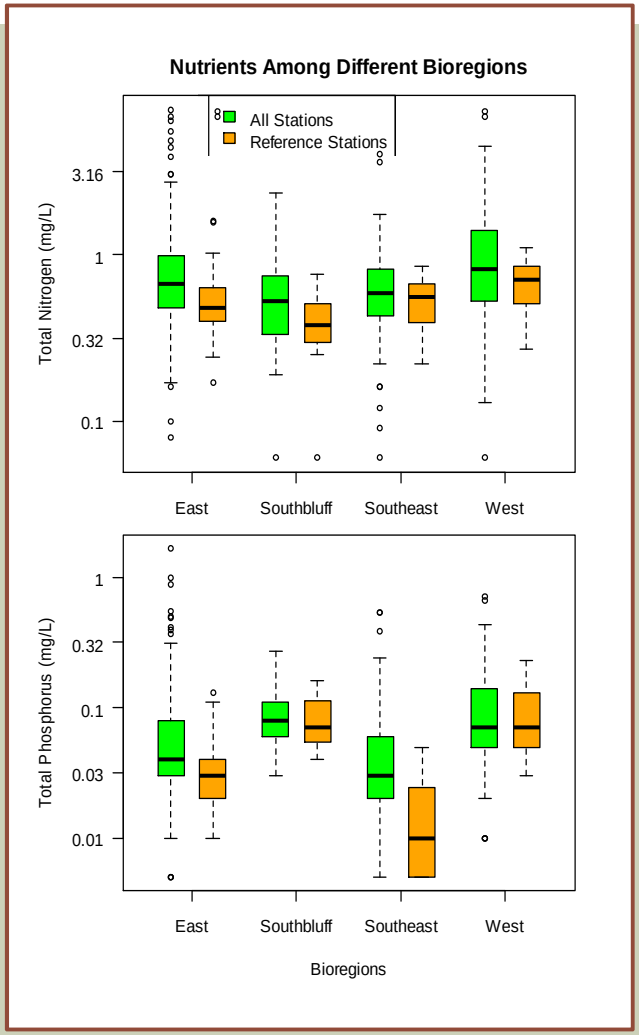
CLASSIFICATION

- Classification –
  - 4 (West, South Bluff, Southeast, and East)
    - Could split West into North and South
  - Based on ecoregions and bioregions



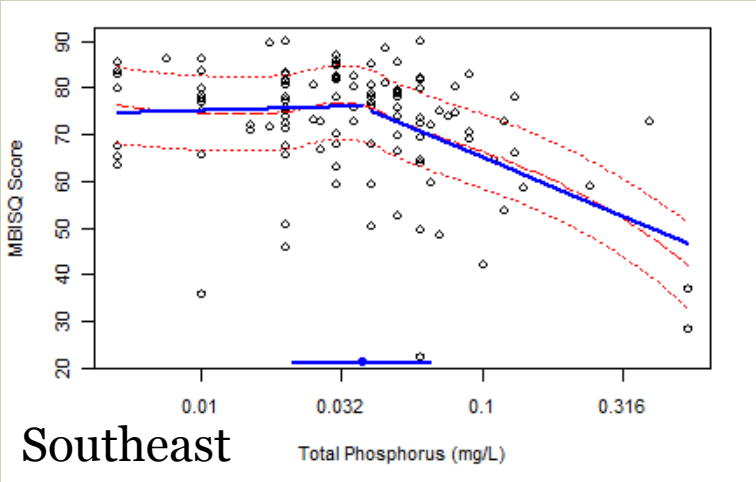
ANALYSIS - REFERENCE

- Reference Approaches
  - Least Disturbed Conditions (LDC)
    - 75th percentile of reference sites
  - Biologically Healthy Conditions (BHC)
    - Meeteing current biological goals
    - 75th percentile of concentrations

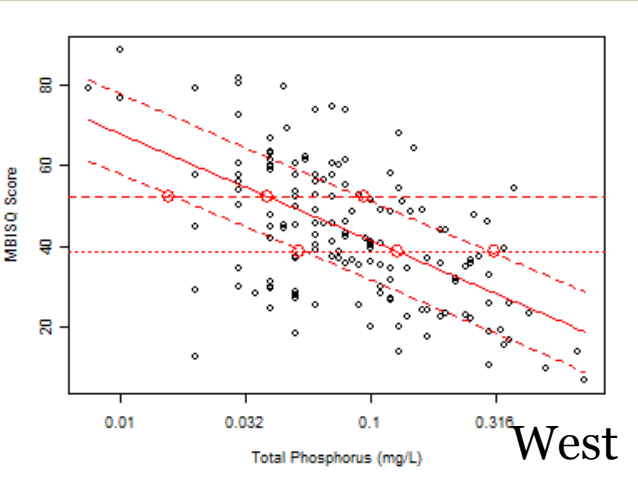


ANALYSIS – STRESSOR-RESPONSE

- Stressor-Response
  - Approaches differed by bioregion depending on the relationship (linear/non-linear)
  - Incorporating latest empirical modeling science/guidance



Southeast



West

ENDPOINT RANGES - STREAMS

TP

30-130 μg/L

Distribution

20-200 μg/L

Literature

40-120 μg/L

Stressor-response

Models

TN

0.46-0.94 mg/L

Distribution

0.18-2.0 mg/L

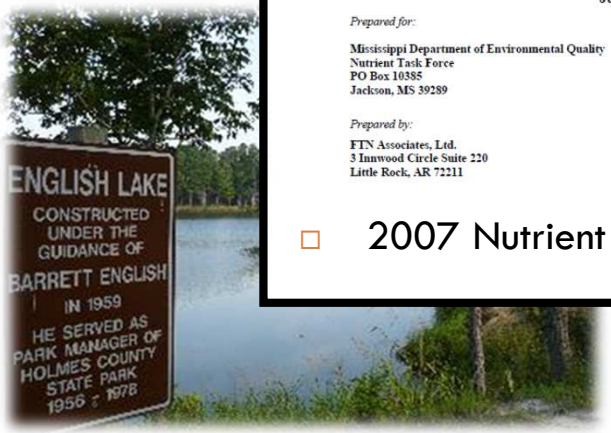
Literature

0.31-1.2 mg/L

Stressor-response

Models

Lakes



NUTRIENT ASSESSMENTS SUPPORTING DEVELOPMENT OF NUTRIENT CRITERIA FOR MISSISSIPPI LAKES AND RESERVOIRS

Final Project Report: Grant Number X974454-06

Submitted

To

EPA REGION IV

July 2007

Prepared for:

Mississippi Department of Environmental Quality
Nutrient Task Force
PO Box 10385
Jackson, MS 39289

Prepared by:

FTN Associates, Ltd.
3 Innwood Circle Suite 220
Little Rock, AR 72211

- 2007 Nutrient Endpoints Report

Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Lakes and Reservoirs

Photos: Mississippi Department of Wildlife, Fisheries, and Parks

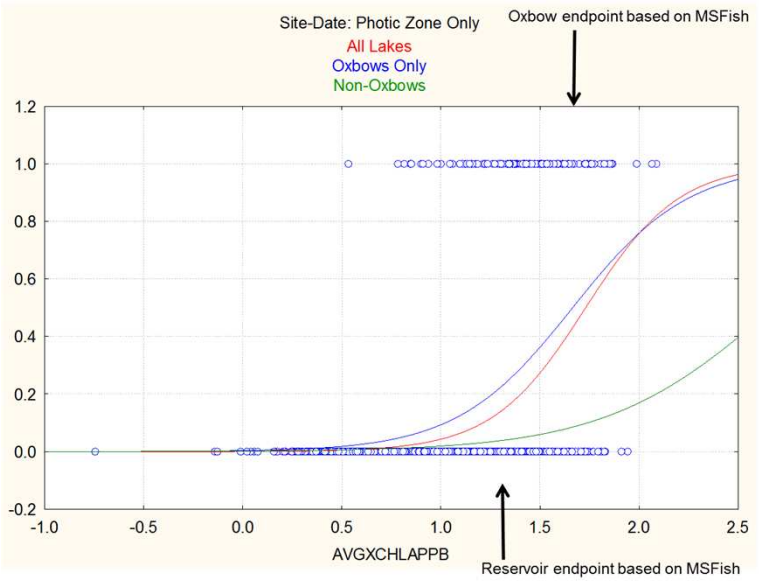
June 8, 2011

- 2011 Nutrient Endpoints Update

Big Picture

1. Data Gathering/Exploration
   Completed

2. Classification
   Completed



3. Data Analysis
   Final Refinement

4. Recommended Thresholds
   Ongoing

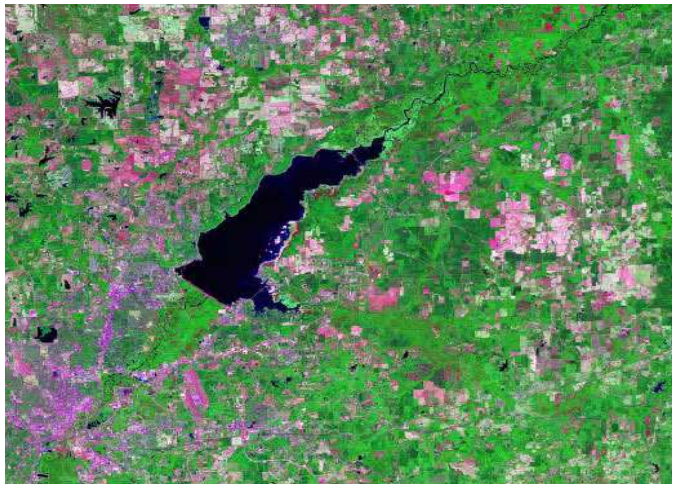
Data Gathering

- MDEQ Statewide Lake Sampling Program
  - Nutrient and response information
- US Army Corps Data on Corps Lakes
- USDA/ARS and USDA/NRCS

Classification

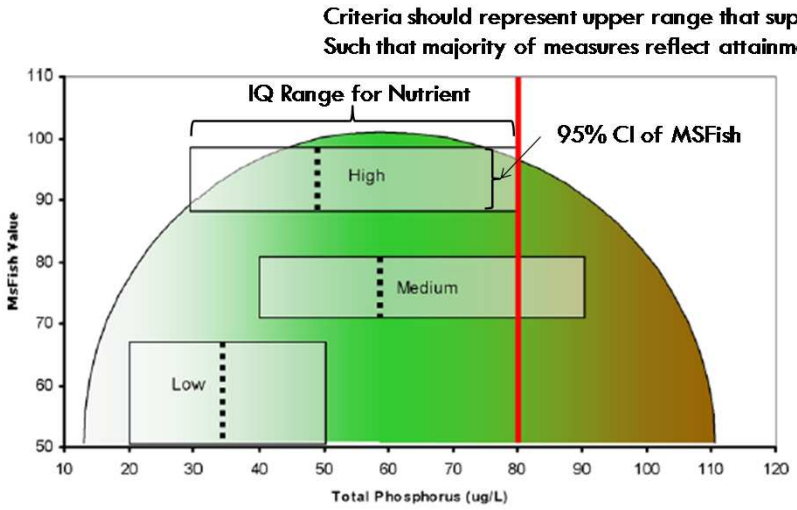
- Various Analyses

- All indicate that reservoirs vs oxbows are the most sensible classes

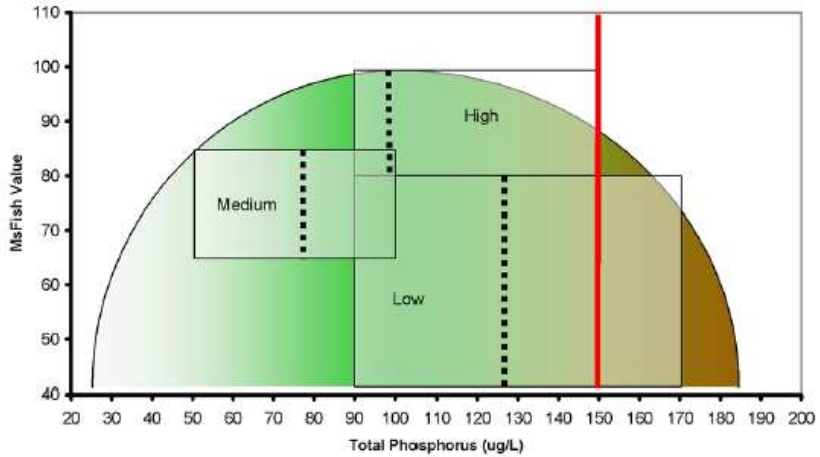


Analysis – Stressor-Response

- Reference abandoned because of lack of reference sites
- Stressor response - MSFish



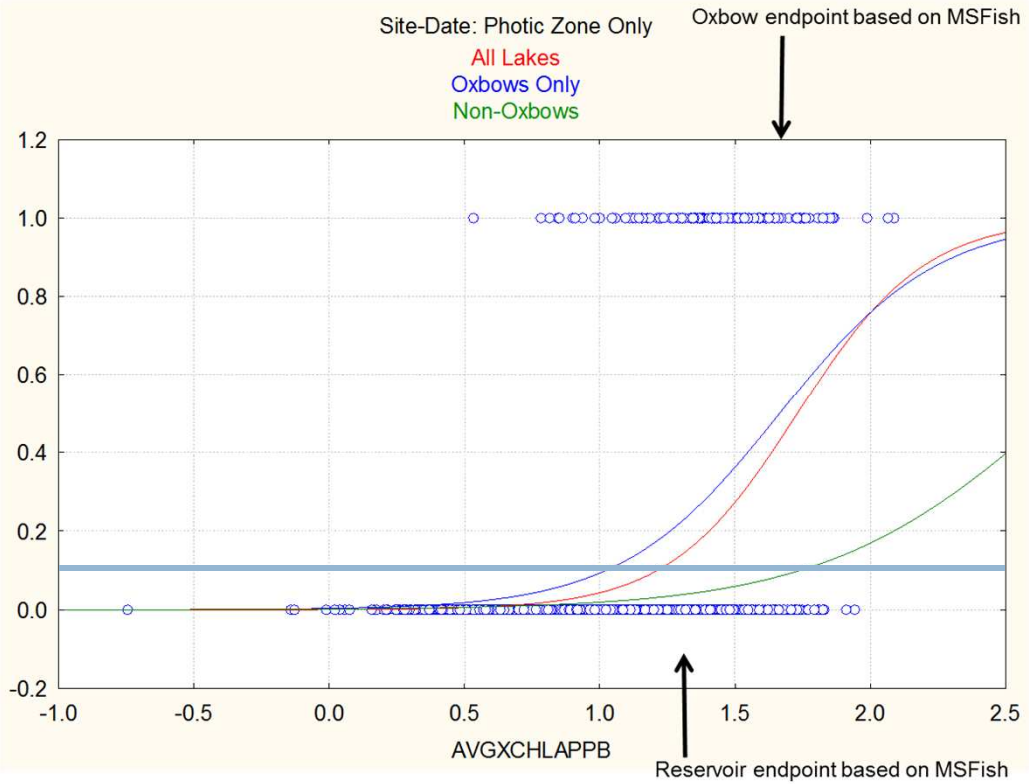
Reservoirs



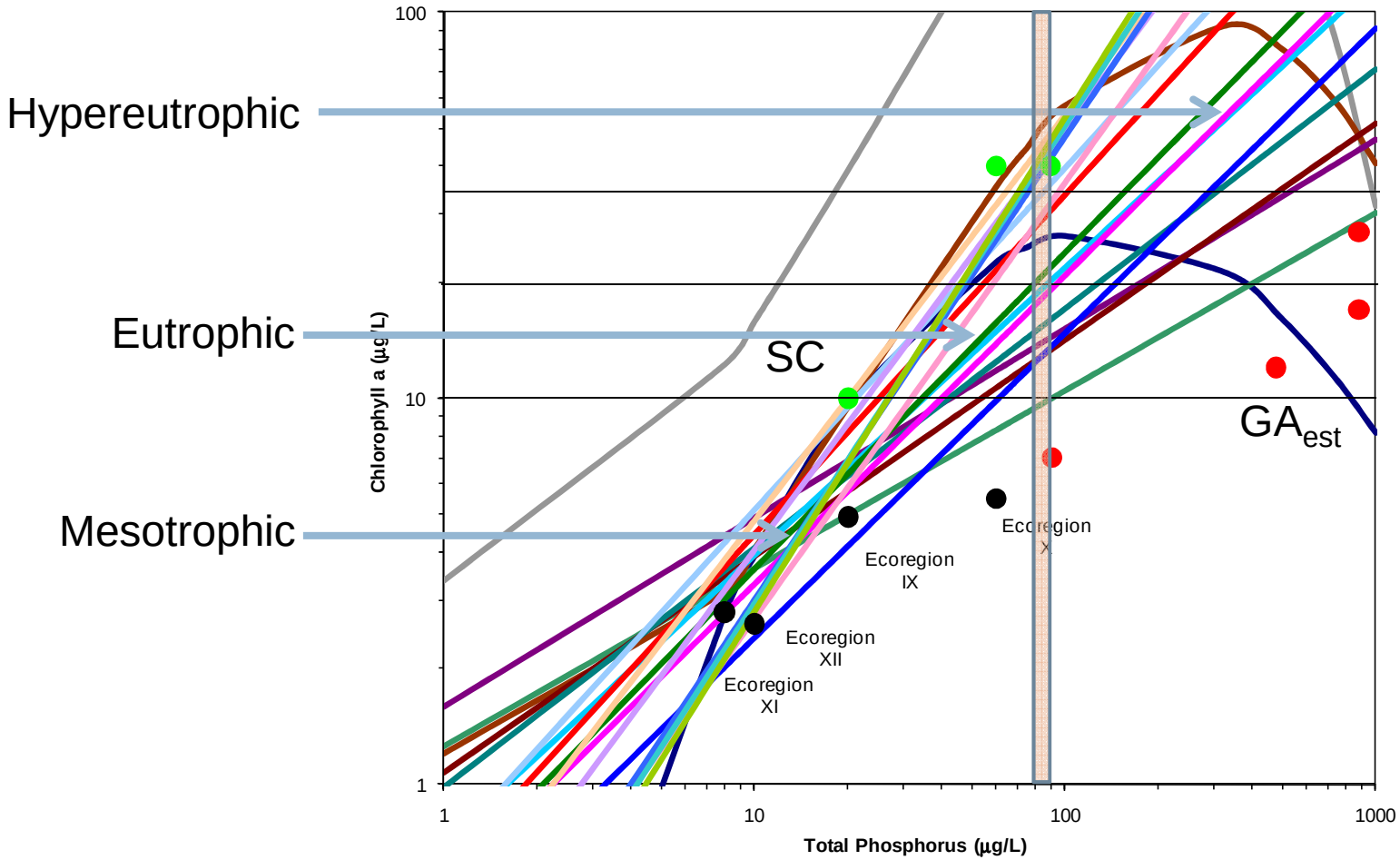
Oxbows

Analysis – Stressor-Response

- DO based analysis
  - Likelihood of violating DO standards
  - Solve TP and TN to meet Chl a



Scientific Literature

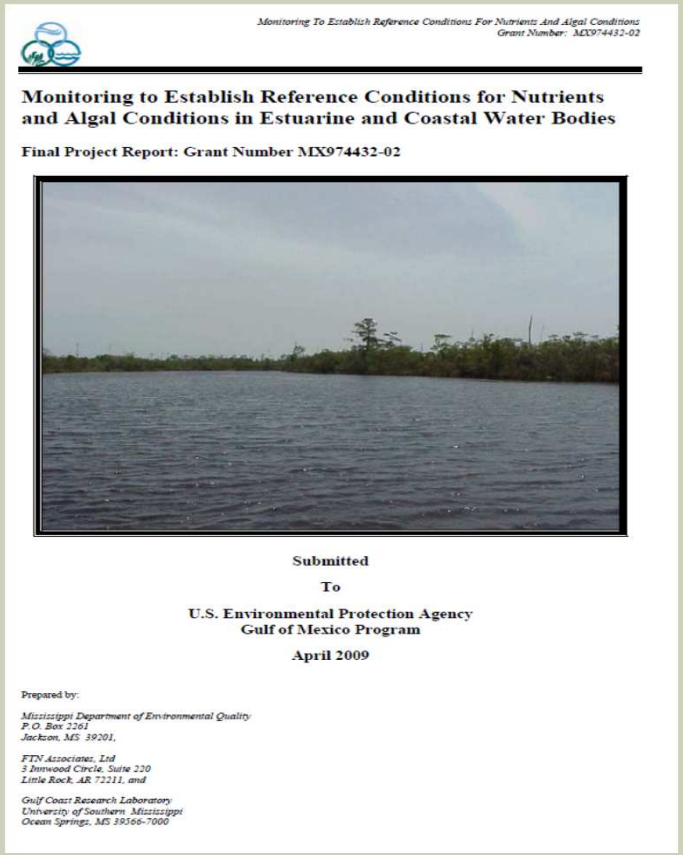


Endpoint ranges - Lakes

Chl a	**3-25 μg/L**	Distribution	**5-40 μg/L** Literature
	19-68 μg/L	Stressor-response	Models
TP	**10-70 μg/L**	Distribution	**20-100 μg/L** Literature
	80-150 μg/L	Stressor-response	Models
TN	**0.36-1.0 mg/L**	Distribution	**0.35-4.0 mg/L** Literature
	1.0-1.6 mg/L	Stressor-response	Models

COASTAL WATERS

- Monitoring Efforts and Criteria Report



Monitoring To Establish Reference Conditions For Nutrients And Algal Conditions
Grant Number: MX974432-02

Monitoring to Establish Reference Conditions for Nutrients and Algal Conditions in Estuarine and Coastal Water Bodies

Final Project Report: Grant Number MX974432-02

Submitted

To

U.S. Environmental Protection Agency
Gulf of Mexico Program

April 2009

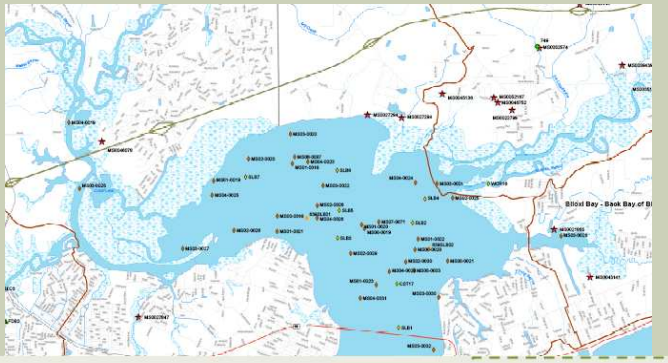
Prepared by:

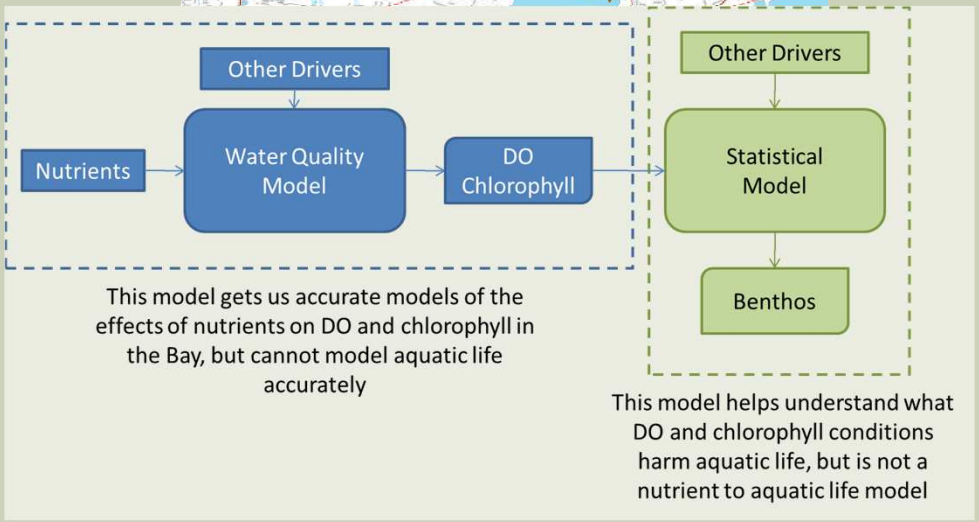
Mississippi Department of Environmental Quality
P.O. Box 2261
Jackson, MS 39201,

FTN Associates, Ltd
3 Innwood Circle, Suite 220
Little Rock, AR 72211, and

Gulf Coast Research Laboratory
University of Southern Mississippi
Ocean Springs, MS 39566-7000

- GOMA Nutrient Sources, Fate, Transport, and Effects Pilot





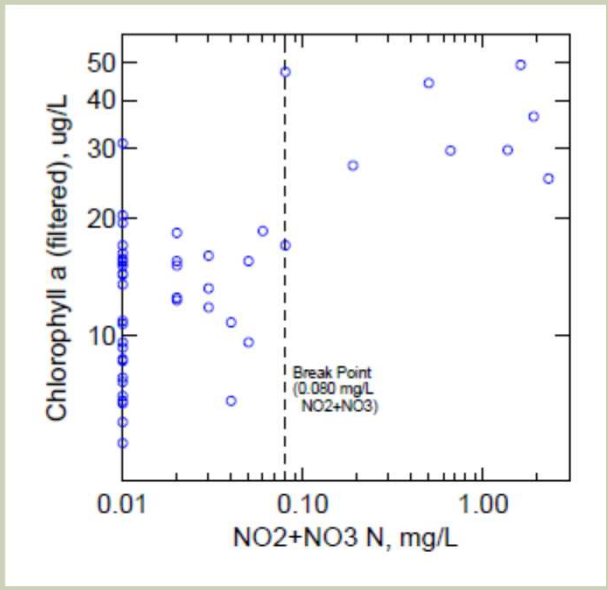
This model gets us accurate models of the effects of nutrients on DO and chlorophyll in the Bay, but cannot model aquatic life accurately

This model helps understand what DO and chlorophyll conditions harm aquatic life, but is not a nutrient to aquatic life model

BIG PICTURE

1. Data Gathering/Exploration
   <u>Completed</u>

2. Classification
   <u>Ongoing</u>



3. Data Analysis
   <u>Ongoing</u>

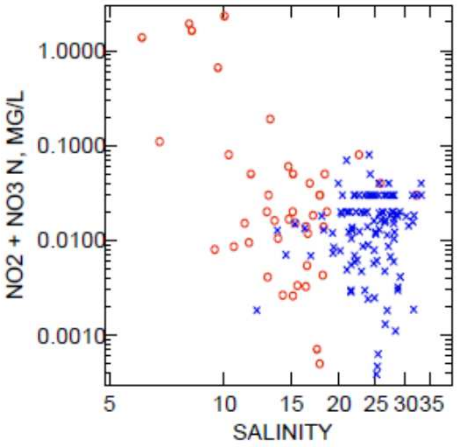
4. Recommended Thresholds
   <u>Ongoing</u>

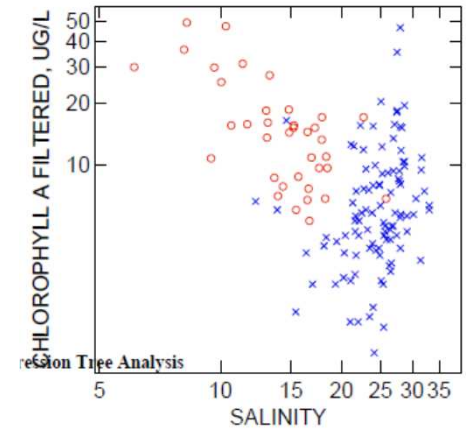
DATA GATHERING

- Coastal Monitoring
  - Ongoing for decades (Ambient Fixed Station Network, Basinwide Network, Coastal 2000, Beach Monitoring Network, Special Studies)
  - Concerted efforts in ~2000 onward
  - 2003, 2004 and 2007 (QA)– Nutrient Focused Coastal Monitoring
  - National Coastal Assessment/Mississippi Coastal Assessments up through 2010
  - Regular Sampling through 2000's
- Nutrient Studies (2003-2004)
  - Characterizing temporal/spatial patterns
  - 3 salinity zones (0-0.5, 0.5-25, >25 ppt)
  - Focus on nutrients, chl-a, clarity, sonde data
- Gulf of Mexico Alliance Bay Saint Louis Nutrient Source, Fate, Transport, and Effects Study

CLASSIFICATION

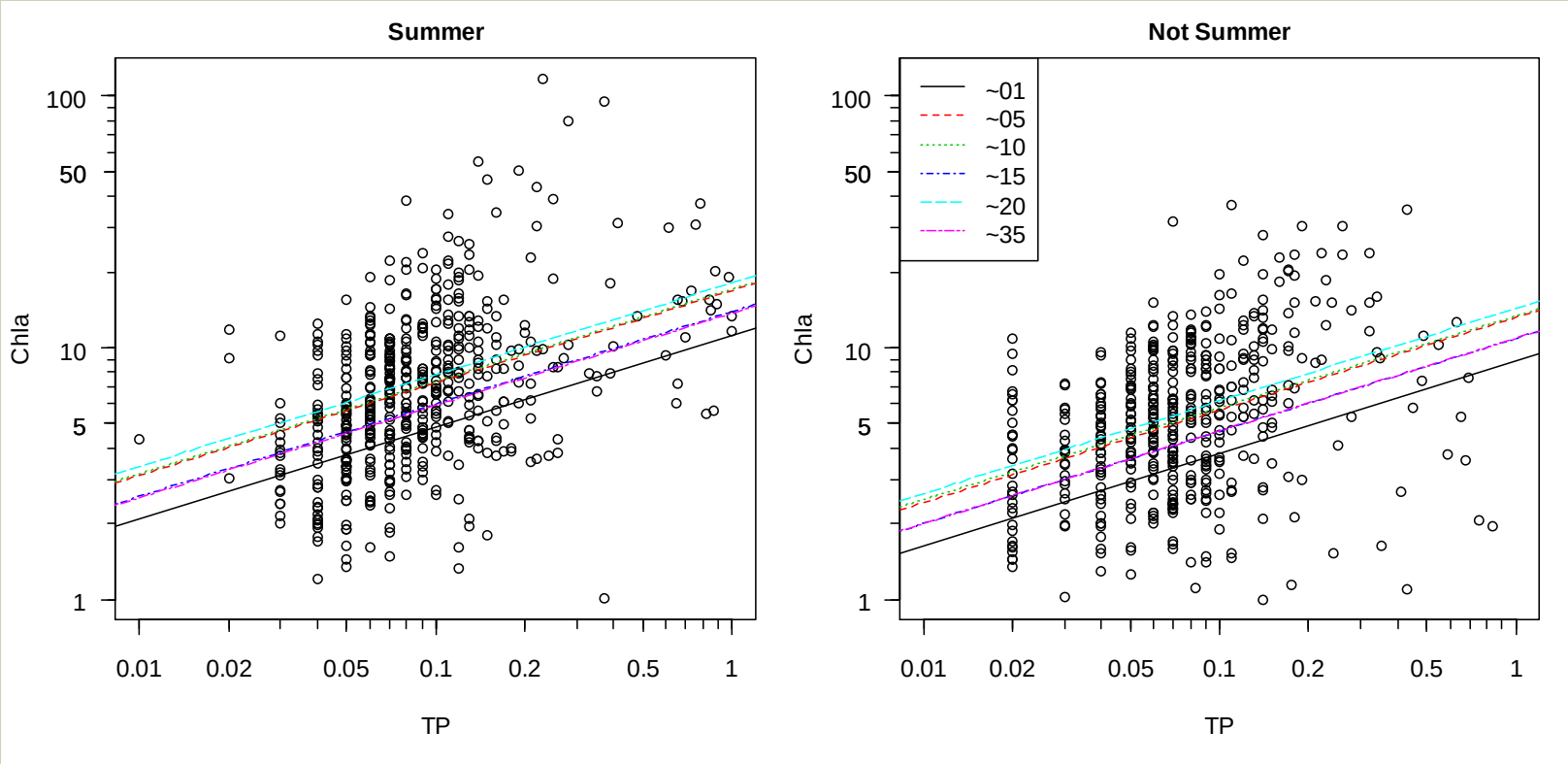
- Evaluated individual river systems
- Evaluated East vs. West
- Evaluated Bays vs. Sound
  - Greatest potential for differences
- Continuing to look at salinity, bay vs. sound, and tidal creeks





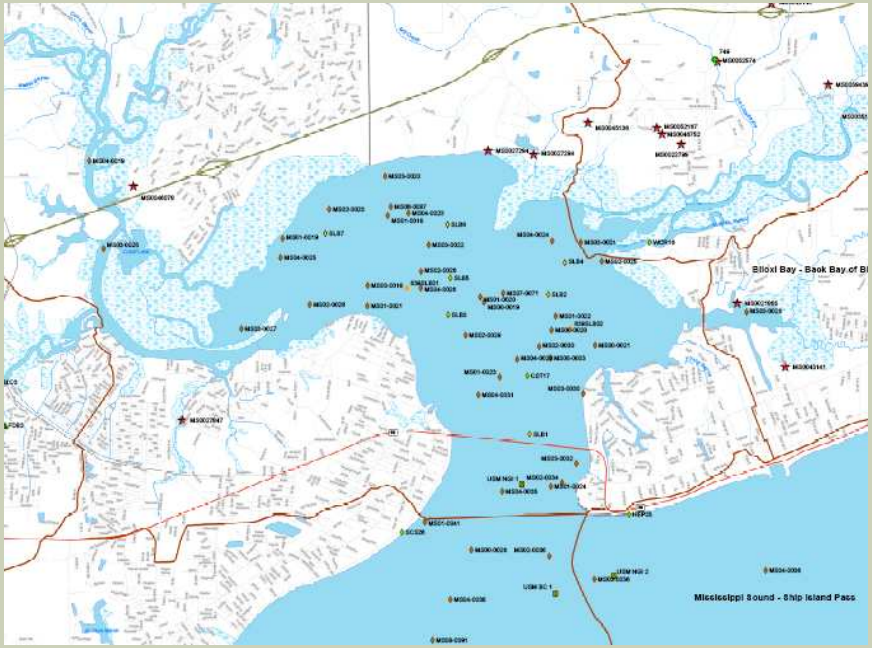
ANALYSIS – STRESSOR-RESPONSE

- Simple regressions – solve at Chl a targets
- Analyzing inter-annual, inter-seasonal, and salinity effects



SCIENTIFIC LITERATURE

- National Studies
- Gulf of Mexico research
- Other state criteria
- Other countries



ENDPOINT RANGES - COASTAL

Chl a

Distribution

Stressor-response

Literature

Models

TP

Distribution

Stressor-response

Literature

Models

TN

Distribution

Stressor-response

Literature

Models

Stay Tuned

RECOMMENDATIONS

- Early days of analysis
- Develop defensible chlorophyll/clarity targets for use in modeling
- Ongoing classification
- Ongoing data analysis using expanded datasets
  - MCA
  - NCA
- Second TAG meeting – tomorrow!

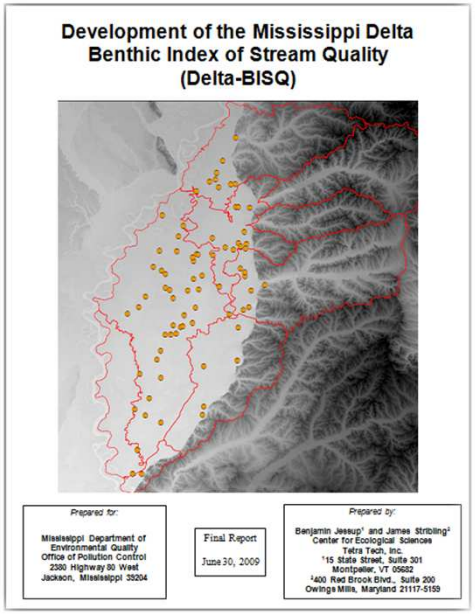
Delta Waters

- Designated Uses in Delta Waters
  - Aquatic Life
  - Recreation
  - Drinking Water

Big Picture

1. Data Gathering/Exploration
   <u>Ongoing</u>

2. Classification
   <u>Ongoing</u>



3. Data Analysis
   <u>Ongoing/Just Begun</u>

4. Recommended Thresholds
   (see lake analysis)

Data Gathering

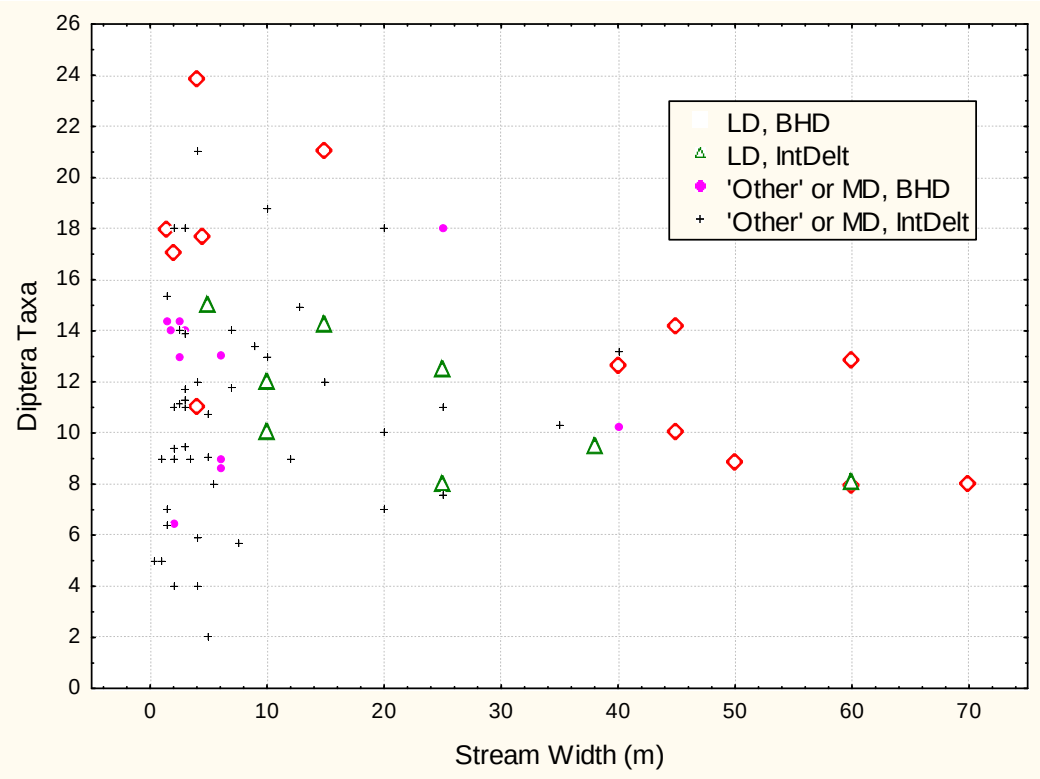
- MDEQ Ambient Monitoring Program
  - Streams
- USGS – Various studies
- USDA ARS – Several studies
- US Army Corps of Engineers

Classification

- Plan to investigate as for other waterbodies
- Preliminary analysis for biological indicators

DELTA – BISQ Classification

- Interior Delta (IntDelt) (western)
- Bluff Hills Drainage (BHD) (eastern)



Reference and Stressor-Response

- Multiple lines of evidence
  - Reference/Distribution – may need to be modeled reference

TMDL Target Values Based on Reference Approach

	West (WADES/USGS)		East (USGS)	
	TP (mg/L)	TN (mg/L)	TP (mg/L)	TN (mg/L)
Lower Quartile	0.16	1.05	0.09	0.58
MBISQ Reference			0.05	0.55
Suggested Targets	0.16	1.05	0.09	0.58

  - Stressor-response approach
    - As with non-delta streams
    - Linked to biological indicators

Literature Review

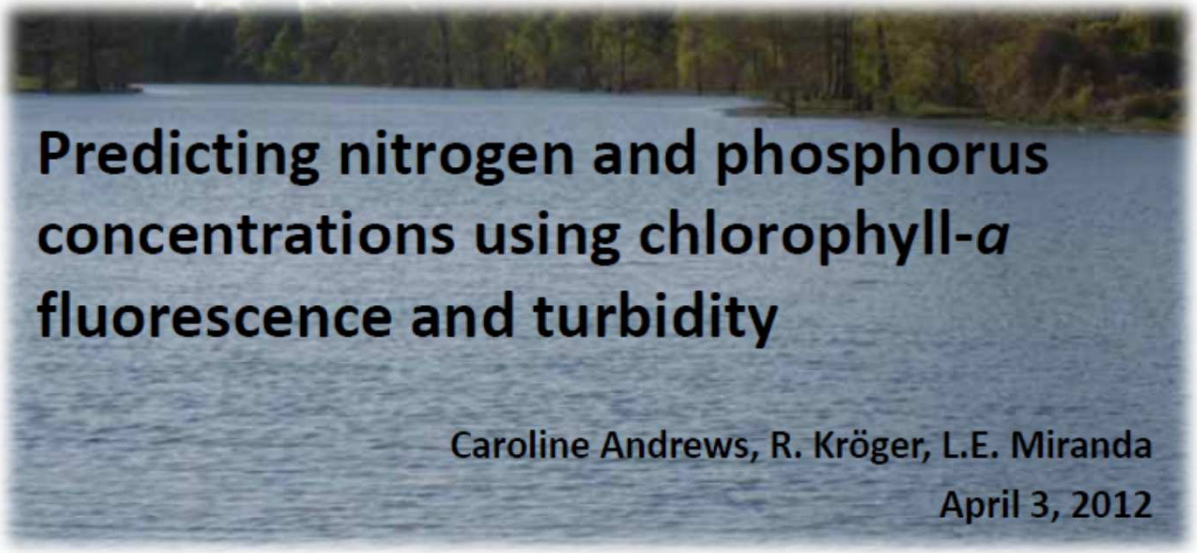
- Based on non-delta review, adjacent regional studies, agency studies, and other available defensible materials.


USGS
science for a changing world

National Water-Quality Assessment Program

RELATIONS OF STREAM FISH COMMUNITIES TO PHYSICAL AND CHEMICAL PARAMETERS AND LAND USE IN THE MISSISSIPPI ALLUVIAL PLAIN ECOREGION

Open-File Report 03-31



Preliminary thresholds

- Stay Tuned